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Seventeenth and eighteenth annual reports, Bulletin, no. 129

New Hampshire Agricultural Experiment Station

Bulletin 129. January, 1907.

NEW HAMPSHIRE COLLEGE

Agricultural Experiment Station.

Seventeenth and Eighteenth Annual Reports.

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS,
DURHAM.

AGRICULTURAL EXPERIMENT STATION.

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* Nov. 1st, 1906.
† Resigned Oct. 1st, 1906.
‡ Resigned Oct. 15th, 1906.

SEVENTEENTH ANNUAL REPORT TO THE UNITED STATES GOVERNMENT ON THE HATCH FUND

FOR THE YEAR ENDING JUNE 30, 1905.

Receipts.

Cash received from United States treasurer....	$15,000.00

Expenditures.

Cash paid for salaries	$8,884.40
labor	1,982.52
publications	1,040.36
postage and stationery.....	86.68
freight and express.....	138.99
heat, light, water and power....	105.89
chemical supplies	74.87
seeds, plants and sundry supplies	501.40
fertilizers	331.74
feeding stuffs	160.96
library	259.50
tools, implements, and machinery	247.47
furniture and fixtures.....	317.08
scientific apparatus	453.87
live stock	73.50
traveling expenses	96.87
contingent expenses	157.09
buildings and repairs.....	86.81
	$15,000.00

SUPPLEMENTARY STATEMENT OF FUNDS OTHER THAN THE HATCH FUND FOR THE YEAR ENDING JUNE 30, 1905.

Receipts.

Cash received, analytical fees, etc	$1,702.83

Expenditures.

Cash paid for salaries and labor	$361.24
freight and express	4.79
heat, light, and water	500.00
apparatus and supplies	88.53
library	.75
tools, implements, and machinery	1.20
furniture and fixtures	14.26
traveling expenses	25.55
buildings and repairs	92.16
Balance	614.35
	$1,702.83

EIGHTEENTH ANNUAL REPORT TO THE UNITED STATES GOVERNMENT ON THE HATCH FUND

FOR THE YEAR ENDING JUNE 30, 1906.

Receipts.

Cash received from United States treasurer....	$15,000.00

Expenditures.

Cash paid for salaries	$8,415.47
labor	2,415.11
publications	1,146.47
postage and stationery.....	72.09
freight and express	183.19
heat, light, and water.....	645.26
chemical supplies	22.40
seeds, plants, and sundry supplies	322.06
fertilizers	224.93
library	165.08
tools, implements, and machinery	167.72
furniture and fixtures.....	108.35
scientific apparatus	655.04
contingent expenses	39.88
traveling expenses	264.15
building and repairs.....	152.80
	$15,000.00

FIRST ANNUAL REPORT TO THE UNITED STATES GOVERNMENT OF THE ADAMS FUND

FOR THE YEAR ENDING JUNE 30, 1906.

Receipts.

Cash received from United States treasurer....	$5,000.00

Expenditures.

Cash paid for salaries	$929.00
labor	528.48
publications	5.80
postage and stationery.....	21.20
chemical supplies	20.55
seeds, plants, and sundry supplies	574.21
fertilizers	343.96
library	237.50
tools, implements, and machinery	308.03
scientific apparatus	1,388.08
live stock	396.45
building and repairs.....	246.74
	$5,000.00

The Adams Act, passed by Congress March 16th, 1906, appropriated five thousand dollars to be expended during the fiscal year ending June 30th, 1906. The above sum is to be increased two thousand dollars annually until the appropriation reaches fifteen thousand dollars annually. This fund has enabled us to plan our work on a much more extensive scale than formerly.

The progress of the work in the several departments of the Station will be noted under the appropriate headings, as reported by the officers in charge.

DEPARTMENT OF CHEMISTRY.

FRED W. MORSE.

November 1st, 1904--October 31st, 1905.

During the year most of the time available for research was devoted to soil studies. The samples of soil were limited principally to the College Farm and were drawn from the different fields. They represented different types of soil and varied methods of handling. Samples of the grass crop were also gathered for a study of the fertilizing constituents. The data are not yet full enough to warrant publication and the work will be continued.

At the request of the Agriculturist, several analyses of silage crops were made, and also, a series of oat samples representing the different weights per bushel of market oats, was studied. The figures obtained in the last mentioned study are given below.

COMPOSITION OF OATS.

Weight per bu.	Water	Ash.	Protein.	Fiber.	Nitrogen, free extract.	Fat.
42 lbs.	8.24	4.08	10.54	8.78	63.25	5.11
40 "	6.84	3.17	11.07	9.85	63.95	5.14
40 "	6.28	3.49	11.18	10.22	63.63	5.20
38 "	8.16	3.80	11.45	10.36	61.76	4 47
38 "	5.84	3.83	11 06	10.08	63.95	5.24
28 "	6.69	3.93	9.74	13.72	61.70	4.2
28 "	6.64	4.28	9.68	13.70	61.62	4.03
28 "	7.52	4.76	9.56	13.44	60.51	4.21

It will readily be noted that the light oats are inferior to the heavy grades in protein, fat and extract (*i. e.*, starch, etc.), while the fiber or most indigestible portion is higher. This difference is due to the fact that the light oats contained about ten per cent. more hulls than the heavy oats.

There is but little difference in the composition of the various heavy grades, although what difference there is to be seen, favors the heaviest lot, with the lowest percentage of fiber. Throughout the series, the average fiber increases, as the average weight of oats drops. But it may be concluded that in purchasing the three heavy grades, one can afford to pay a price proportioned to the weight per bushel.

The inspection work on fertilizers and feeding-stuffs occupied more time than usual and the experiment work was much hindered on account of the difficulty of keeping an

assistant chemist at the salary allowed. Harry D. Batchelor, Albert C. Blaisdell and Edward H. Goodnow have successively occupied the position, the last named being the present incumbent.

Nov. 1st, 1905--Oct. 31st, 1906.

During the first half of the year the department was occupied with the study of the soil samples and grass samples collected during the summer of 1905. Studies were made of the content of humus and total fertilizing constituents of the soils, total fertilizing constituents of the grass crop, and water soluble potash in the soils.

During the past summer, vegetation tests have been carried on with two different types of soil, and numerous samples of grasses, forage crops and soils have been prepared for subsequent analysis this winter. The particular phase of the soil problem selected for study, is the availability of the natural potash present in the soil of the College Farm, since there is shown by analysis to be an abundance of that constituent.

The increasing demand for chemists in manufacturing and pure-food inspection resulted in the resignation of Mr. Goodnow in May. Fortunately for this Experiment Station the Adams Act now renders it possible to pay a more liberal salary, but it was not until almost the end of the present year that the right man could be secured, owing to the brilliant opportunities now open in agricultural investigation. October 15th Mr. B. E. Curry, M. S., of Cornell University, began his duties as Associate Chemist and it is confidently hoped that the work of the department will continue some time with no breaks like those of the past.

A series of analyses of silage crops and silage is published in the following table. The samples were collected and analyzed at the request of the Agriculturist, and were in part done last year and in part this year.

COMPOSITION OF VARIETIES OF FODDER AND SILAGE.

SAMPLE.	Date of Taking.	Water.	Dry Matter.	COMPOSITION OF DRY MATTER.				
				Ash.	Fiber.	Protein.	Nitrogen-free Extract.	Fat.
Oats and Peas	Aug. 4, '04	77.21	22.79	8.85	29.52	9.98	49.08	2.57
Oats and Peas	Aug. 5, '04	75.75	24.25	7.99	30.89	10.51	48.09	2.52
Oats and Peas	Sept. 1, '04	72.95	27.05	8.27	32.68	10.74	45.58	2.73
Oats and Peas	June 5, '05	77.32	22.68	7.72	34.37	8.18	39.01	10.72
Clover	Sept. 3, '04	67.66	32.34	7.33	23.35	15.62	50.83	2.87
Clover	Mar. 17, '05	78.83	21.17	7.31	32.30	18.49	34.75	7.15
Leaming Corn	Sept. 20, '04	83.34	16.66	4.91	25.45	9.12	56 92	3.60
Sandford Corn and Soja Bean	Sept. 24, '04	72.33	27.67	8.17	29.05	11.77	48.02	2.99
Leaming Corn	Jan. '06*	79.18	20.82	5.20	27.01	7.32	53.72	6.75

*Average of three samples, crop of 1905

DEPARTMENT OF HORTICULTURE.

F. W. Rane.

November 1st, 1904--October 31st, 1906.

The experimental work in this department since last report of 1904 and up to the present has been along the following lines:

1. Plant Breeding.
2. Forestry.
3. Orchard survey of state.
4. Trial grounds testing experiments.
5. Forcing crops under glass.
6. Strawberry experiments.
7. Monographic studies with vegetables.

The experimental work has gone forward with interest and enthusiasm, not a small part of which has been due to the fine and earnest support given by the department's assistants.

In plant breeding there is at present much valuable data on hand, particularly the results from crossing various vegetables. We have many seedlings of promise in squashes, cucumbers, melons, tomatoes, peppers and pumpkins. It is believed that some of this work when completed will prove conclusively that earlier experiments were not carefully enough done to warrant their conclusions. Some plant breeding work has been taken up simultaneously in a limited way with other plants but not on a large enough scale to warrant mention now.

The crossing and plant breeding of the carnation has been taken up upon an extensive scale. About 70 distinctive combinations of crosses were successful and the seedlings from this beginning covered a large area when set out of doors this year. Very careful notes have been taken of all of the plants and at present there are numerous very promis-

ing seedlings being grown in three of the college greenhouses which have been set aside for this work. Not only has the department crossed and grown these seedlings but a very close study has been made of the pedigree of the parent stocks.

The orchard survey work has but fairly gotten under way. Rockingham County has been well covered and some beginning made elsewhere.

The trial ground tests continue as one of the features of the work of the department. This work is believed to be responsible in many ways for our efficiency in bringing practical and valuable things to horticulturists generally.

The forestry experiments relative to the practical handling in reforestation, as well as improvement cuttings, have been continued with increasing interest.

The forcing of crops under glass, particularly during the winter months, has received attention from the experimental standpoint, as in previous years.

A fine bed of strawberries was set last spring with a view of determining comparative values in fertilizing them for maximum production. A fine selection of varieties for comparative tests was also set.

It has been the custom of the department for a few years to make a monographic study of a few crops each year. Such a study has been made of the muskmelon and watermelon, heretofore reported upon and published in bulletin form. The material is on hand and half tone cuts made for a similar bulletin on squash, which would have been published before this had there been time to compile and edit the data.

Similarly has the data been taken and necessary photographs for illustrating types of the following vegetables, pumpkins, beets and cabbage.

During the past few years some very valuable notes have been made in a very large number of horticultural varieties that should be of great value to the department in future work. Mr. Harry F. Hall, who was my associate until September 1st; Mr. Clarence Fowler and Mr. W. E. Belle-

ville, the latter assistants in the department, have all worked untiringly and devotedly toward keeping the experimental work to a standard of reliable efficiency.

In resigning on October 1st, it was only with much reluctance and in believing that a new field of opportunity lay before me for effective work. The eleven years of my connection with the college, during which time the horticultural work was first started I trust is a beginning toward making horticulture and forestry of ever greater importance throughout the commonwealth of the old Granite State.

DEPARTMENT OF AGRICULTURE.

FRED W. TAYLOR.

November 1st, 1904--October 31st, 1905.

I beg to submit the following summarized report on the work of this department for the year ending July 1st, 1905:

I. ORGANIZATION AND EQUIPMENT.

The position of farm foreman, which had been filled very acceptably by Mr. Percy A. Campbell for two years, was vacated September 1st, 1904, by his resignation, and remained unfilled until April 1st, 1905, when Mr. F. A. Tinkham assumed charge. On September 1st Mr. W. R. Dewhurst of Nuneaton, England, was secured as herdsman. Mr. Dewhurst resigned his position and returned to England in May, 1905, Mr. D. B. Stevens, a graduate of the Dairy School, taking his place.

During the year a considerable amount of labor was expended in laying out and establishing permanent plots for experiment purposes. Four acres were laid out into one-tenth acre plots with two-foot alley-ways between them, and

two acres into one-twentieth acre plots. The plots are arranged in sections of ten plots each, and all corners are marked with iron stakes. A little over one mile of permanent farm roads have been established, which not only aid in the improvement of the farm but add greatly to the convenience of conducting field tests.

The old rectangular silo in the dairy barn was found to be in a bad condition. New cement sills were put in, the corners cut off, making it slightly octagonal, new lining with acid and water-proof paper behind it was put on and a new silage chute constructed, the total amount expended for repairs being $98.73. The silo has been filled three times since then and is in first class condition. A new blower elevator ensilage cutter was purchased in the fall of 1904 and has given excellent satisfaction, although about one-third more power is required to run it than the old chain elevator type. A combined grass, grain and fertilizer drill was purchased during the year, and the fact has been demonstrated beyond doubt that more uniform stands of grass and grain can be secured and the fertilizer applied more evenly at a less cost for labor than by any broadcast method. A sheep shearing machine which was also installed during the year demonstrated that a slightly heavier fleece can be obtained, a smoother and neater appearance made with less danger of cutting the animal than by hand shearing.

II. Grains and Grasses.

Oats.—Thirteen varieties of oats mentioned in the last annual report were sown in the spring of 1904. All the varieties started out nicely and had every appearance of making a good yield until the time of filling when the rust struck them badly. Although some varieties seemed more resistant than others, no grain was produced by any of them.

Corn.—Fourteen varieties of corn (seven dent and seven flint) were tested on tenth-acre plots. The average yield per acre of the dents was 56.0 bushels and of the flints 44.4 bushels. Duplicate tests of thick and thin planting of corn

for the comparative yields of grain and fodder were also made, but the records are being reserved for a separate bulletin on "Corn Culture."

Clover.—Forty-six samples of clover and alfalfa seed secured from various sources by the United States Department of Agriculture were sown in small plots, 5x10 feet, in a co-operative experiment with that department. Out of the forty-six samples eleven of red clover gave good stands, *i. e.,* five from France, two from Bohemia, one from Holland, one from Moravia, one from Virginia and one from Kansas.

Roots.—Three varieties of mangels,—Golden Tankard, Long Red and Gate-post were planted and yielded respectively 6,400, 7,760 and 8,800 pounds per acre. Two varieties of sugar beets, the Kleinwanzlebener and Yellow French, yielded at the rate of 5,800 and 3,320 pounds per acre, respectively. The season was not favorable for the growth of the roots and hence the low yields. The comparative merits of the different varieties may, however, be judged. The best yields of turnips have been secured when the seed has been sown the middle of July at the rate of 12 ounces per acre. The seed is most conveniently sown when mixed with coarse sand or sawdust. Rape, although not a root crop, is to be recommended as a hog and sheep feed. The best yields have been obtained when shown broadcast at the rate of four pounds per acre. Seed and harrow in as early as possible in the spring.

Peas and Beans.—The "Clay" and "Whip-poor-will" varieties of cow peas were tested with the largest yield in favor of the former, although neither variety did well enough to warrant its planting as a field crop in this section. Canada field peas sown with barley or oats yielded a little over two tons per acre of an excellent quality of hay much relished by dairy cows.

Soy beans (medium green variety), planted in drills, reached an average height of three feet and yielded four tons per acre of green forage. The soy beans, mixed with corn in the silo, improve the quality of the silage.

Fertilizers and nurse crops for seeding down.—Four one-acre plots were seeded down with oats, barley, oats and peas and barley and peas, as nurse crops. Thirteen one-tenth-acre plots were used to determine the comparative efficiency and cost of the various carriers of nitrogen, potash and phosphoric acid, and by arranging different combinations to determine in which element the soil was the most deficient. Another series of tests on the fertilization of mowing lands will be completed next year and the data, together with that of the two preceding tests, published in a bulletin on "Grasses and Forage Crops."

III. Feeding.

Cost of wintering yearlings.—During the winter of 1904 an experiment was carried out with four lots of heifers, two in each lot, to study the cost of wintering and to make a comparison of different rations. Lot I received bran, corn meal and linseed meal; Lot II, bran, corn meal and gluten feed; Lot III, bran, corn meal and cotton-seed meal; and Lot IV, bran and corn meal. Each lot received hay and ensilage for roughage. During the five and one-half months of the experiment the cost of keeping was $19.28 for lot I; $20.86 for lot II; $20.95 for lot III; and $20.64 for lot IV. Aside from the cost of keeping, lot I, which received linseed meal, came out of the experiment in the best condition. This was followed by lot III, lot IV and lot II, respectively.

Light and heavy oats for horses.—The three work teams of Percheron blood owned by the college were used in this experiment which extended over a period of sixty days. The horses were in harness every working day of the period and performed a grade of farm labor which required average exertion and endurance. They were paired as follows: Rob and Bess, Mag and Nell, Frank and Prince. From July 25th to August 23rd, Rob, Nell and Prince (one horse from each team) each received 16 pounds of heavy oats per day,—5 lbs. in the morning, 5 lbs. at noon and 6 lbs. in the evening. For the same period Bess, Mag and Frank each received the

same number of pounds of light oats. From August 24th to September 22nd the grades of oats were reversed so that the horses which received the heavy grade during the first thirty-day period received the light grade during the second period. During both periods the horses were allowed to eat what they wanted of an average quality of mixed hay. The weights of the horses were taken twice a week on successive mornings before watering to note any changes. The average of these two weighings is taken as the weight for that particular week.

Summary of weights:—

WHEN ON HEAVY OATS.

	Rob	Bess	Mag	Nell	Frank	Prince
Weight at beginning	1352	1361	1429	1238	1377	1278
Weight at end	1351	1372	1460	1256	1395	1281
Gain or loss	-1	11	31	18	18	3

WHEN ON LIGHT OATS.

Weight at beginning	1351	1341	1406	1256	1415	1281
Weight at end	1340	1361	1429	1260	1377	1302
Gain or loss	-11	20	23	4	-38	21

Total gain on heavy oats ..... 81 pounds
" " " light " ..... 68 "
" loss " heavy " ..... 1 "
" " " light " ..... 49 "

One horse lost on both light and heavy oats.

Five horses gained on heavy oats.

Four horses gained on light oats.

The total gain or loss in any case was not material, and was not much greater than the variation in weight from one day to another.

OATS FED IN THE EXPERIMENT.

Sample No.	Grade.	Price.	Wt. per bu.	Where bought.	Amount.
1	Heavy	.65	42.5	Dover	20 bus.
2	"	.55	37.5	"	30 "
3	"	.55	40.0	Haverhill	20 "
4	"	.62	37.5	Concord	20 "
5	Mixture	.59	39.5	.....	90 "
6	Light	.52	28.0	Concord	20 "
7	"	.52	27.5	Concord	70 "
8	Mixture	.52	27.5	.....	90 "

COMPOSITION TABLE (Morse.)

Sample No.	Water.	Ash.	Protein.	Fiber.	Extract.	Fat.
1	8.24	4.08	10.54	8.78	63.25	5.11
2	8.16	3.80	11.45	10.36	61.76	4.47
3	6.84	3.17	11.07	9.85	63.93	5.14
4	5.84	3.83	11.06	10.08	63.95	5.24
5	6.28	3.49	11.18	10.22	63.63	5.20
6	6.69	3.93	9.74	13.72	61.70	4.22
7	6.64	4.28	9.68	13.70	61.62	4.08
8	7.52	4.76	9.56	13.44	60.51	4.21

PER CENT. OF KERNEL AND HULLS.

Sample No.	Kernel.	Hulls.
1	70.6	29.4
2	68.7	31.3
3	71.6	28.4
4	67.4	32.6
5	70.6	29.4
6	60.0	40.0
7	59.1	40.9
8	61.7	38.3

The percents of kernels and hulls were obtained by weighing out 5 grams of the oats, and then carefully separating the hulls from the kernels and weighing again.

The practical results of this experiment seem to indicate that, pound for pound, the light oats have nearly the same feeding value as the heavy oats. Although the heavy oats contain a higher per cent. of protein, fat and nitrogen free extract, and a less per cent. of fiber than the light oats, it seems probable that the relative proportions of these constituents in the two grades are such that they are more easily and thoroughly digested. Some digestion trials, however, will be necessary to decide this point. The per cent. of kernel, as would be expected, bears a close relation to the weight per bushel. It should be remembered that although the two grades are practically equal, pound for pound, they are not equal, quart for quart, and that in feeding by measure, as is usually done, due allowance should be made for the heavy oats and a less quantity given. Since oats are bought and sold by weight instead of measure there seems to be no gain made in buying the heavy oats at a much advanced price over the light oats.

IV. Drainage.

A complete system of underdrainage was installed in the permanent plots referred to in the beginning of this report, 4,390 feet of drain tile being used. With this work as a practical basis, bulletin No. 118 was prepared. This bulletin which discusses the principles and practices of tile drainage as applied to New Hampshire conditions was the only publication issued by this department during the year.

November 1st, 1905--October 31st, 1906.

The following report on the work of this department, for the year ending July 1st, 1906, is herewith submitted:

I. Organization and Equipment.

On April 1st Mr. F. A. Tinkham, after a year of efficient service, resigned the position of farm foreman to take charge of an estate in the town of Ossipee. Mr. Geo. S. Ham of

Barrington succeeded Mr. Tinkham and has filled the position very acceptably. Mr. J. C. Lyons, a graduate of the 1906 Dairy Course, succeeded Mr. Stevens as herdsman on April 1st. There have been no changes in the supervising force for three years. Prof. E. L. Shaw has had direct charge of the feeding experiments thus far carried out and will conduct those in sheep breeding and poultry feeding hereafter mentioned.

Pressing hay.—In the spring of 1905 a belt power horizontal hay press was purchased to secure data regarding the actual cost of pressing hay. In April 48 tons were pressed up with the following items of expense:—

Labor	$42.40
Wire	14.40
Power	7.23
Repairs	3.35
Total	$67.38
Cost per ton	$1.40
Average weight of bales	132 lbs.

In January 51 tons were pressed at the following cost:—

Labor	$42.73
Wire	11.32
Power	7.65
Total	$61.70
Cost per ton	$1.21
Average weight of bales	155 lbs.

In October 46 tons were pressed at the following cost:—

Labor	$54.30
Wire	11.89
Power	6.90
Total	$73.09
Cost per ton	$1.59
Average weight of bales	120 lbs.

The labor has been figured at $1.50 per day for ordinary laborers, and $2.00 per day for the foreman. The power used was taken from the central college plant and the cost of this was based on the cost of gasolene if a gasolene engine had been used, and was estimated at 15 cents per ton. The average price of baling hay throughout the state is $2.00 per ton, with board and lodging for the usual crew of four men furnished besides one or two extra men for getting the hay to the press. The year previous to baling our own hay the pressing was hired done at a cost of $2.71 per ton, which cost represents about what the average farmer must pay. On the basis of this price the 145 tons pressed would have cost $392.95, while the actual cost of pressing was $202.17, or a saving of $190.78, which represents about 75 per cent. of the first cost of the press, or about 40 per cent. of the first cost of a complete outfit, including press and gasolene engine. The cost of pressing is slightly less the heavier the bales are made, since the press can be fed faster and less wire is required. The market demand in a 17x22-inch bale is for one weighing between 100 and 120 pounds.

Dynamometer.—An Eickemeyer and Osterhald Dynamometer was purchased in the fall of 1904 and a series of tests on the draft of wagons and farm implements are being carried out from time to time as the opportunities are presented. The results of these tests are to be published in bulletin form later on.

Corn planter and cultivators.—A two-horse corn planter and two two-horse cultivators were recently purchased for the purpose of demonstrating to what extent they are an economy over the single-horse implements.

Sulky-plow.—A reversible sulky-plow has also been purchased recently for use in dynamometer tests and for a comparison of its work with that of walking hillside and landside plows.

Fertilizer distributor.—One of the large broadcast fertilizer distributors was purchased in the spring for use in the fertilizer tests on corn and grass.

Engines.—A 3 H. P. gasolene engine was purchased for operating the milking machine hereafter noted, and a 15 H. P. steam engine for cutting ensilage and fodder, grinding feed, pressing hay, etc.

Drainage.—A car-load of tile was purchased in the spring to increase and extend the systems of drainage begun a year ago.

II. Grains and Grasses.

Oats.—On account of the unfavorable results due to the attacks of rust in 1904 no oats were planted in 1905. Eight common varieties secured from various New England seedsmen were planted this spring and yielded from 28 to 40 bushels per acre, varying in weight from 31 to 40.5 pounds per bushel.

Corn.—Twenty-two varieties of corn were planted this season on one-tenth acre plots. Twelve of these varieties grown in various other northern states, were furnished by the United States Department of Agriculture. The remaining ten were secured from local seedsmen or collected in various parts of the state. Fertilizer and cultural tests are also being made on a series of tenth-acre plots. The results of all the corn tests are being held for a separate bulletin.

Alfalfa.—Attempts have been made for the past four seasons at this Station and in different parts of the state, to secure uniform stands of alfalfa. Different times and methods of seeding have been tried; various fertilizers and inoculating cultures have been used; different types of soil have been tested, but thus far no uniformly satisfactory results have been obtained. It has been learned, however, and the present season's trials indicate, that the proper time for seeding is the month of July after the ground has been thoroughly cultivated and freed from weeds for six weeks or longer. The use of lime and a liberal supply of fertilizers also seems necessary. Inoculation of the soil with other soil in which alfalfa has been grown for a number of years has been reported to be beneficial. Although the growing of

alfalfa as a hay and forage crop would be highly desirable in this state, its place is easily and successfully taken by red clover, and until further investigations have been made regarding the methods of culture for New Hampshire conditions, this Station is not in a position to recommend the plant.

III. Feeding.

Protena ration.—A feeding test extending over a period of sixty days was conducted to determine the comparative cost of a "protena" ration and a mixed variety ration. The mixed ration consisted of a mixture of 100 lbs. bran, 100 lbs. corn meal, 100 lbs. cotton seed, 100 lbs. linseed and 100 lbs. Union Grains. Two Jersey cows in approximately the same period of lactation were fed on each ration, receiving 8 lbs. apiece per day of the grain together with what mixed hay they would eat. The cows on the protena ration produced during the sixty days 1,048.2 quarts of milk, equivalent to 146.36 lbs. of butter, while the cows on the mixed ration produced 1,211 quarts of milk, equivalent to 166.54 lbs. of butter during the same period.

The cost of the protena was $26.00 per ton, and the amount consumed by the two cows for the sixty days was worth $12.48. The amount of the mixed ration consumed was worth $13.32, valuing the bran, corn meal, cotton seed, linseed and Union Grains at $23.00, $23.40, $32.00, $33.00, and $28.00 per ton, respectively.

The cost per quart of milk produced was 1.19 cents for the protena and 1.10 cents for the mixed ration. The protena, which is made up largely of ground alfalfa, is more or less dusty and forms a sticky paste in the mouth, and for that reason was not eaten with the same relish as the variety ration.

An experiment was also carried out on the feeding of protena and skim milk to pigs. During thirty days, five three-months-old pigs made a total gain of 151 lbs., at a cost of 3.27 cents per pound. The bulky nature of the protena

had a distending effect on the pigs' stomachs and induced a rapid and healthy growth.

Silage versus grain.—A feeding test to determine to what extent silage can be made to replace grain in the dairy ration was carried out last winter on the College herd. This question yet remains to be supplemented by further tests which will be conducted as soon as opportunity permits. It has already been found, however, that the flow of milk is lessened as the amount of grain is reduced and is not fully restored as the amount of silage is increased. The exact data regarding cost of rations, quality of milk and condition and healthfulness of the animals are not ready for publication.

IV. Poultry.

The poultry work has been planned to secure data concerning the use of various prepared and condimental feeds as against exclusive corn, wheat, barley, dry mash and certain variety rations.

Four colony houses, 6x8, with a scratching shed underneath, have been constructed at a cost of $15 each, and are intended to accommodate 15 birds. A study of the advantages and disadvantages of colony houses as regards temperature and general healthfulness, together with a comparison of glass and canvas for windows, is to be made.

While the poultry work is not being attempted on a large scale, it is designed to determine certain important points which are of interest to all poultry raisers in the state.

V. Sheep Breeding.

In the sheep breeding work which will be conducted during the coming winter, the primary object will be to determine the best breed or cross-breed for the production of early spring lambs for the Boston market. The principal points of consideration will be, (1) weight at birth, (2) rapidity of increase in weight, (3) vigor and healthfulness, (4) weights at market time, (5) character and per cent. of carcass.

Pure bred Southdown and Dorset-horn types will be studied together with the following cross-bred types:—

1.—Southdown ram on grade down ewes.
2.—Southdown ram on grade merino ewes.
3.—Dorset-horn ram on grade down ewes.
4.—Dorset-horn ram on grade merino ewes.
5.—Hampshire ram on grade down ewes.
6.—Hampshire ram on grade merino ewes.

A certain number of the ewe lambs will be matured for the purpose of determining the quality of wool, weight of fleece, size and hardiness of the cross-bred types at maturity, and to study the cost of keeping sheep under average New England conditions.

VI. Milking Machine.

One of the B-L-K milking machines was recently installed in the dairy barn for the purpose of making certain investigations into the practicability of machine against hand milking. As soon as the details of operation have been acquired and the cows have become accustomed to the machine a test of its practical working will be begun and extend over a period of six months or longer. In this test a comparison of hand and machine milking will be made as regards the following points:—

1. Cleanliness or sanitary condition of the milk.
2. Time required for milking.
3. Amounts of milk given.
4. Cost of milking.

Also a study of the machine milker to determine:—

1. Durability of machine and equipment.
2. Effect upon the flow of milk from continued use.
3. Effect upon the temperament and healthfulness of the cows.
4. What improvements could be made.

The whole milking machine test resolves itself into an answer to two leading questions, (1) Is the milker a practical machine for the average dairyman? (2) With what size herds can it be economically used?

DEPARTMENT OF ENTOMOLOGY.

E. Dwight Sanderson.

November 1st, 1904--October 31st, 1906.

I. Administration.

Assistance.—Until June, 1905, Mr. J. C. Bridwell, now professor of Biology in Pacific University, served as assistant in both Station and college work, his work upon the classification of the collection being particularly valuable. From June, 1905, to June, 1906, Mr. J. L. Randall, New Hampshire College, 1905, served as graduate assistant. July 1, 1906, Mr. T. J. Headlee, Ph. D., Cornell, 1906, was elected assistant in Entomology and since then has devoted nearly his entire time to entomological investigations in a most efficient and painstaking manner.

Equipment.—Valuable additions to the equipment of the department have been made, especially during the past year under the Adams Fund. A supply of rearing cages of various styles in which to rear insects while studying their life histories, have been built. One of the most complete photographic outfits has been installed, the products of which illustrate this report. Valuable additions have been made to the department library. Several recording thermographs for records in connection with our study of effects of temperature upon insect life have been purchased and much miscellaneous apparatus. Several spray pumps have been given us for testing by the makers. The one need for the prosecution of efficient work by this department is an insectary in

which plants and insects may be successfully grown for study.

Collection.—The insect collection grows steadily, an inventory showing about 25,000 specimens, including about 2,000 named species. Many sections of the collection are but partially determined and are in the hands of specialists for identification. During the past year most of the collection has been transferred to blocks and put in condition to ensure its permanent preservation.

The writer has endeavored in every way possible to furnish information concerning insect pests and to encourage our citizens to better combat them. To this end some twenty addresses have been given before granges, farmers' institutes, and various clubs and organizations. Three hundred and fifty letters of inquiry concerning insect pests have been received and about the same number of replies sent. A list of the insects so identified follows:

INSECTS RECEIVED FOR INDENTIFICATION,

Oct. 1, 1904 to Oct. 1, 1906.

Scientific Name.	Food.	Locality and Date.
	COLEOPTERA.	
Calligrapha scalaris Lee.	Elm.	Concord, V, 9, 05.
Ellychnia corrusca Linn.		Pittsfield, XI, 6, 05.
Euphoria inda Linn.	Apple.	Pittsfield, XI, 6, 05.
Hylobius pales Hbst.		Pittsfield, V, 6, 05.
Ips fasciatus Oliv.		Claremont, VIII, 1, 06.
Lachnosterna tristis Fab.	Raspberry.	Wilton, VI, 14, 06.
Macrodactylus subspinosus Linn.	Rose, Cherry, Grape, Peach, Plum.	Chester, VIII, 6. 06.
Otiorhynchus ovatus Linn.		Wilton, VII, 26, 05.
Pterostichus stigicus Say.		Pittsfield, V, 6, 05.
	HEMIPTERA.	
Aphis gosypii Glover.	Melons.	North Weare, IX, 1, 05. Concord, VIII, 9, 05; V, 17, 06 Dover Point, VIII, 12, 05.

Aphis viburni Scop.	Snowball.	Belmont, IX, 3, 05.
Aspidiotus perniciosus Comst.	Apple.	Newington, V, 6, 05.
Callipterus ulmifolii Monell.	Elm.	Claremont, VII, 25, 06.
		Franklin, VII, 24; Littleton, VII 24; Rochester, VII, 20 06.
Chermes pinicorticis Fitch.	Pine.	Concord, V, 22, 06.
	Pine.	Auburn, V, 23, 05.
Enchenopa binotata Say.	Plum.	Hillsboro Bridge, VII, 27, 06.
Lecanium.		
Lepidosaphes ulmi Bouche.	Apple.	Centerville, VI, 13, 05; Antrim, V, 7,; Rochester, V, 14; Merrimack, IV, 30, 06; New Hampton, X, 3, 05; Concord, IV, 8 06.
Myzus cerasi.	Cherry.	Rochester, VI, 21, 06.
Necturophora pisi Kalt.	Pea.	Derry, IV, 06.
Pemphigius acerifolii Riley.	Maple.	Wilton, VI, 05; W. Salisbury, VII, 9; Pittsfield, VII, 7, 06.
Psylla pyri Forst.	Pear.	Walpole, VII, 5, 06.
Schizoneura americana Riley.	Elm.	Rye Beach, VII, 5, 05.
		Conway Center, VI, 15, 06.
		Tilton, VI, 21, 06; Berlin VII, 16, 06.
Schizoneura lanigera Hausm	Apple.	Woodsville, VII, 6, 06.

HYMENOPTERA.

Eriocampes cerasi Peck.	Pear.	Effingham, VIII, 29, 06.
Kaliosysphinga ulmi.	Elm.	Claremont, IX, 7, 06
Monostegia rosae Harris.	Rose.	Loudon, VII, 5, 06.
Tremex columba Linn.	Maple.	Wilton, VIII, 29, 06.
Thalessa lunata Fab.		Franklin, VI, 17, 05.

LEPIDOPTERA.

Ampelophaga myron Cram.	Woodbine.	New London, VIII, 30, 06.
Anisopteryx pometaria Harr.	Maple.	Haverhill, VI, 13, 06.
Automeris io Fab.		Rochester, VIII, 26, 05.
Callosamia promethea Dru.		Kingston, III, 17, 05.
Cingilia catenaria Cram.	Sweetfern.	Rochester, VIII, 26, 05.
Clisiocampa americana Fab.	Peach.	Peterboro, V, 1, 06; Raymond, III, 20, 05.
Datana integerrima G. & R.	Hickory.	Atkinson, VIII, 12, 05.
		Newington, VIII, 20; Hampton Falls, VIII, 25, 06.
Datana ministra Dru.	Apple.	Pittsfield, Rochester, VIII, 26, 05; Wolfboro, VIII, 8; Wilton VIII, 1; Enfield, X, 2, 05; Rochester, IX, 8; Center Sandwich VIII, 14; Wendell, IX, 3; West Concord, VIII, 13, 06.

Drasteria erechto Guen.		Pittsfield.
Euvanessa antiopa Linn.	Elm.	Centerville, VII, 16, Rochester, VIII, 26, 05; Winchester, VII, 18; Keene, VI, 19; Nashua I, 22; Danbury, VIII, 6; Deering, VII, 9; Warner, VI, 15; Exeter, VI, 22; New Ipswich, VII, 16; Dover, VI, 30; Peterboro, VI, 27; Concord, VI, 22; No. Andover, VI, 25; Hollis, VI, 20; Brookfield, VI, 30; East Hebron, VII, 9; Portsmouth, VIII, 5; Chesterfield, VII, 24; Winchester, VI, 18; Bristol, VII, 13; Berlin, VII, 16, 06.
Halisidota caryae Harris.	Hickory. Butternut.	Contoocook, VIII, 1, 05; Warner, VII, 3; Wilton, VIII, 6, 06.
Halesidota maculata Harr.	Poplar.	Berlin Mills, VIII, 27, 06.
Hyphantria textor Harr.	Apple.	Concord, IX, 1, 05; Rochester, VIII, 26, 05.
Lycomorpha pholus Dru.		Pittsfield, VIII, 26, 05.
Hemerocampa leucostigma S. & A.	Apple.	W. Rumney, VII, 26, 06; Sunapee, IV, 7; S. Lee, III, 30, 06.
Notolophus antiqua Linn.	Apple. Pear. Raspberry.	Canobie Lake, III, 13; Wilton, III, 14, 05; East Andover, III, 1; Canaan, IV, 20; Alton, II, 20; Farmington, II, 26; S. Lee, III, 30; Exeter, I, 25; So. Wolfboro, VII, 28, 06.
Hapaipema nitela Guen.		Pittsfield, IX, 3, 05.
Papilio troilus Linn.		Westville, VI, 20, 06.
Schizura concinna S. & A.	Apple.	Boscawen, Centerville, Concord, VIII, 10, 05; Concord, VIII, 25 IX, 1; Conway, VIII, 24; Rochester, VIII, 26, 05; Dover, Concord, Portsmouth, VII, 25 Exeter, VIII, 16; Center Tuftonboro, VIII, 29, 06.
Schizura ipomaea Doubld.	Plum.	Fitzwilliam, VIII, 25, 06.
Scoliopteryx libatrix Linn.		Pittsfield, V. 6, 05.
Samia cecropia Linn.		Keene, VIII, 8, 06.
Sphinx gordius Cram.		Rochester, VI, 20, 06.
Xylina prexata Grote.		Pittsfield, V, 6, 05.
Xylina unimoda Lint.		Pittsfield, V, 6, 05.

ODONATA.

Anax junius Dru.		Wolfboro, IX, 1, 05.

CORRODENTIA.

Psocidae.	Maple.	Henniker, VIII, 6, 06.

ACARINA.

Bryobia pratensis Herm.	Clover.	E. Washington, V, 23, 06
Eriophyes crumena.	Maple.	Winchester, VII, 14, 05.
Eriophyes quadripes.	Maple.	Hampton Falls, VII, 4, 06.
Phytoptus pyri Sch.	Pear.	Hooksett, VI, 18; Marlboro, VIII, 14, 06.

PUBLICATIONS.

The following comprise the publications of the writer during the period of this report.

1904, Dec. 23. The Kelep and the Cotton Plant. Science.

1905, Feb. 6. The Brown Tail Moth, etc. Portsmouth Times, Manchester Union, and N. H. daily press.

April. Miscellaneous Cotton Insects in Texas, Farmers' Bulletin No. 223, U. S. Dept. Agr. pgs. 24.

——— Some Observations on the Cotton Boll-Weevil. Proceedings Assn. Economic Entomologists, Bulletin 52, Bureau of Entomology, U. S. D. Agr. pgs. 29-41.

——— A Statistical Study of the Decrease in the Texas Cotton Crop due to the Mexican Cotton Boll Weevil and the Cotton Acreage of Texas, 1899 to 1904 inclusive. Pgs. 28, figs. 7, Dept. of Agr., Ins., Stat., and History, Austin, Texas.

Dec. Insects Affecting Cattle and Methods of Combating Them. Rept. 21st Meeting Granite State Dairymen's Assn. pgs. 38-48, figs. 10.

Dec. 16. Control of the Gypsy Moth. New England Farmer.

Dec. The Gypsy Moth. Bulletin 121, N. H. Coll. Agr. Exp. Sta. pgs. 24, figs. 11.

1906, Jan. Directions for Treatment of Insect Pests and Plant Diseases. Agr. Bulletin, N. H. State Board of Agriculture, Vol. II, pgs. 9-28.

Feb. The Brown Tail Moth in New Hampshire. Bulletin 122, N. H. Coll. Agr. Exp. Sta., pgs. 28, figs. 20.

Feb. Press Bulletin 57, N. H. C. Agr. Exp. Sta., Directions for Sending Insects.

—— Report on Miscellaneous Cotton Insects in Texas. Bulletin 57, Bureau of Entomology, U. S. Dept. Agr., pgs. 63, figs. 33.

March. Spraying the Home Garden. Garden Magazine, pgs. 64-7, figs. 12.

Apr. The Entomological Problem of New England. Cornell Countrymen, pgs. 155-7.

The Rantankerous Brood of Aphides. Garden Magazine, pgs. 150, 151, figs. 9.

May. National Control of Introduced Insect Pests. Popular Science Monthly, pgs. 431-439.

June. Texas Notes. Entomological News, pgs. 210-213, fig. 1.

June. Some Insects that Bother the Melon Patch. Garden Magazine.

July. Spray Grapes Three Times in July. Garden Magazine. Figs. 5.

Aug. Few Bugs in Clean Gardens. Garden Magazine. Fig. 1.

Sept. Four Insect Pests That Are Easily Killed Now. Garden Magazine.

National Control of Introduced Insect Pests. Proceedings Assn. Econ. Entomologists, Bulletin 60, Bur. Entomology, U. S. Dept. Agr., pgs. 95-104.

Notes from New Hampshire, pgs. 74-76 ibid.

Winter Work Against Insects. Garden Magazine, pgs. 178-179, figs. 8.

II. Investigations.

Brown-tail moths.—During the winters of 1904-'05 and 1905-'06 the spread of the brown-tail moth in the state was determined; during the summer of 1905 its life history and habits were studied, and a bulletin concerning it was published February, 1906. The spread during the past summer will be determined this year and an account of the present status of both it and the gypsy moths will be immediately published.

Gypsy Moths.—In the fall of 1905, with the co-operation of the State Board of Agriculture, the existence of the Gypsy Moth in New Hampshire was determined and the infested localities, which include all of the coast towns, were partially located. The writer has kept in touch with the work being done against this insect by Massachusetts and by the Bureau of Entomology, of the United States Department of Agriculture, under a recent appropriation of Congress. A full account of it was published in Bulletin 121, December, 1905. The gypsy moth is the most serious insect pest which has ever threatened New England or the East and we are doing everything possible to arouse public sentiment to the danger of apathy in combating it.

Codling Moth.—Believing that the apple promises to be New Hampshire's most profitable crop, we are making special study of all insects affecting it. The most important of these is the Codling Moth, commonly called "the apple worm." An exhaustive study of the life history and habits of this pest and extensive experiments concerning the best methods of spraying to combat it have been conducted during the past season, and will be continued. A full knowledge of the habits of the pest cannot be secured in a season, but we hope to report fully concerning it in the next biennial report. Spraying experiments were conducted with the co-operation of the orchard owners, Mr. Albert DeMeritt, at Durham; Mr. Wm. H. Weeks, Greenland; Mr. C. E. L. Hayward, Hancock; and Mr. H. H. Thompson and Prof. F. W. Hooper of Walpole. In all 150 trees were

included in these experiments, a preliminary account of which will be published shortly. Such experiments in spraying and also in dusting for our steep hillside orchards, must be continued for several years. In addition, we are arranging for field meetings of farmers at which the actual methods of spraying and the best apparatus will be shown, to be followed by local records of the results to which local attention will be directed. An increasing interest in this subject is very manifest.

The Apple Maggot or "railroad worm" *(Trypeta pomonella)* is an almost equally injurious pest of summer and fall apples, making their profitable production almost impossible in many sections. This insect has received considerable study in Maine, but a satisfactory method for its control under many New Hampshire conditions is still to be devised. A careful study of its life and habits is now being undertaken and experiments with methods of control will be inaugurated next year.

During the past two seasons there has been an unusual abundance of various species of caterpillars which commonly effect the apple tree during late summer. These are discussed more fully in the 28th report of New Hampshire College, pages 319-353, and further observations on them and the other insects of the apple will be continued.

Garden Insects.—Two of the most injurious insects of the garden are the Striped Cucumber Beetle *(Diabrotica vittata)* which affects melons, cucumbers, and all plants of this family, and the Cabbage Root Maggot, which often seriously interferes with the growth of cabbage, radishes, turnips, etc. These insects have been under observation for several years at this Station and numerous experiments have been made with methods of control. Studies of both were made during the past season, but it was impossible to make experiments which were sufficiently conclusive to enable us to give definite advice as to satisfactory means of control. Further studies of these pests will be conducted next year, when we hope to be able to publish definitely concerning them.

Shade Tree Insects.—In addition to the Brown-tail Moth and Gypsy Moth mentioned above, there are numerous insect enemies of New Hampshire shade trees about which little seems to be known and which often require some treatment for their control. The shade trees of New Hampshire are one of its chief attractions and we therefore propose to make a study of some of the more common injurious but little known pests of our common shade trees. Among these have been brought to our attention the mites which produce the galls upon maple leaves *(Eryophyes spp.)* and also various species of plant lice which affect the maple, birch, oak and elm. Several of these have done considerable injury during the past season, but we were unable to devote time to their careful study.

Hibernation of Insects.—The numbers of many kinds of injurious insects are dependent upon the mortality of these insects in hibernation during the winter. It is generally known, therefore, that weather conditions during fall, winter and spring often largely control the numbers of these pests. The exact weather conditions which are conducive to the multiplication or to the mortality of an insect are not, however, definitely known and very little exact study has been given to this important subject. During the past two years we have made preliminary studies upon the relation of temperature to the hibernation and time of emergence of insects in the spring, especially with the Brown-tail Moth, Apple Tree Tent Caterpillar and the Rusty Tussock Moth. With more assistance and better equipment it is now possible to prosecute this research more carefully, and during the present and coming winters we expect to secure considerable exact data concerning the immediate relation of the temperature during the period of hibernation to the time of emergence of insects in the spring, and also the relation of low temperatures to their mortality, as well as the relation of various temperatures to the time required for the various stages in the transformation of insects. It is unnecessary to point out the practical bearings of such investigations in this place, but the fact that the daily press last winter widely

heralded that the Brown-tail Caterpillars had been killed out, due to unusually mild weather in January, which report was absolutely without foundation, shows that exact information upon these matters is needed. We believe that this investigation will have a far reaching importance in establishing some fundamental factors in the natural control of insect life.

Faunal Survey.—New Hampshire is possibly the most interesting state east of the Rockies in regard to the distribution of its animal and plant life, for only in New Hampshire does the so-called Alpine Zone, which occurs at the summit of Mount Washington and a few neighboring peaks, occur. Two other distinct life areas occur within the state. It is well known that certain species of insects can exist only in the life zones or areas to which they are adapted and that in their migrations they often will not become established in zones north of their native habitat. It is, therefore, of both practical and scientific interest to determine the distribution of the insects in the state and to determine exactly what species are here to be found. We have commenced such a record, which may be termed a Faunal Survey of the insects of New Hampshire, and shall compile records of all the insects in our own collection as well as those in other leading collections of the United States and of published records of insects taken in New Hampshire, giving the localities in which each species has been recorded, together with the dates and other necessary information. In this work we have been promised the help of several of the leading specialists in various orders of insects and we trust that ultimately this record may be published as a list of the insects of New Hampshire which will be of considerable service to amateur entomologists, the increasing number of school teachers and high school students interested in entomology, and scientific workers throughout the country.

DEPARTMENT OF BOTANY.

CHARLES BROOKS.

September 1st, 1905—November 1st, 1906.

Within the past year botanical quarters, consisting of an office, a herbarium and a small laboratory, have been fitted up in Nesmith Hall. The equipment has been increased in the way of apparatus for the study of physiological and pathological conditions in plants. Among the additions are an autoclave, an incubator, a parraffin oven and a microtome.

PLANT DISEASES.

The excessive rainfall early in the season made the past summer very favorable to fungous diseases. The department has kept a record of these as they occurred and so far as possible has gathered data in regard to the extent and nature of the injury done. The study has been carried on by means of specimens sent to the station for identification, by watching the produce in the markets, and by making a careful survey of the gardens and orchards in certain sections of the state. The following are some of the diseases that are known to have occurred in New Hampshire the past year. Collections have been made of these and other diseases and the specimens stored in the college herbarium.

DISEASES OF THE APPLE.

Apple Scab [*Venturia pomi* (Fr) Wint.]. This disease is of common occurrence in the orchards of the state. It appears in the spring on the young foliage as velvety, olive colored patches. In severe cases the leaves become shriv-

elled and distorted, eventually dropping off. The fungus also attacks the stems of apples, sometimes causing the young

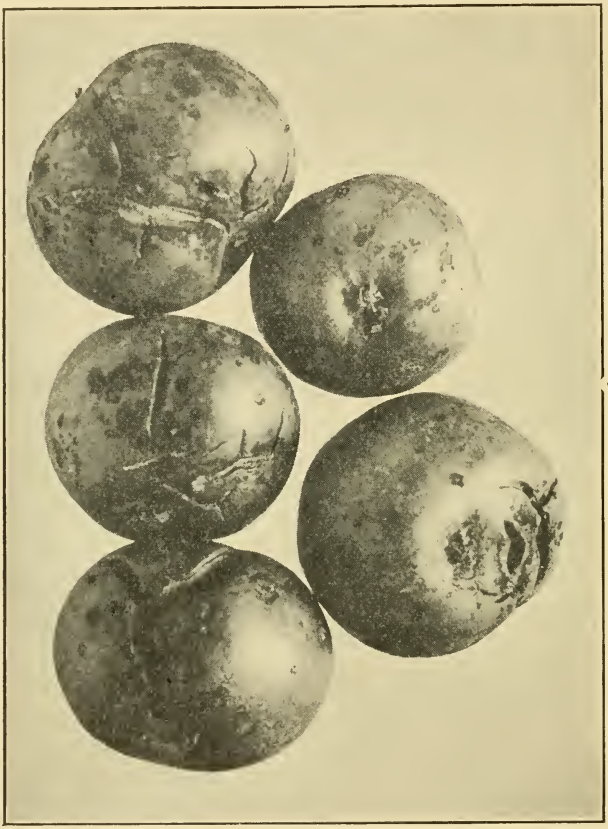

Fig. 11. Apples affected with scab fungus (photo by Lamson).

fruit to shrivel and fall. But the most serious effects of this parasite are found on the fruit. Here the fungus produces olive-black spots, which in their late stages have a narrow margin of light gray. When the scab spots are abundant the fruit is often dwarfed, cracked and deformed;

and in any case it is rendered unsightly and its market value decreased. Aside from the direct injury produced by the disease, the breaking of the skin of the fruit opens the way for the soft rot fungi, which soon destroy it. The spots on the leaves and fruit are the source of an abundant crop of spores, which are able to start the disease at once in new places. The fungus lives through the winter in the fallen leaves producing another form of spore in the spring. These spores are carried by the wind to the young leaves and start the disease anew. Sprayed apples have not suffered from this disease. Black Rot (*Sphaeropsis malorum* Berk.). But very few orchards have been visited in which this disease does not occur. On the leaves it produces brown, dead spots of irregular shape. It attacks the fruit when in its ripening stages or when in storage. Affected apples decay rapidly, turning a reddish brown at first but later becoming black. They gradually dry out becoming much wrinkled and shrunken. On the surface of the rotting apple may be seen numerous small dots called pycnidia. A section through one of these shows it to be filled with egg-shaped spores. These spores escape through an opening at the apex of the pycnidium to start the disease anew. The fungus is also the cause of cankers on the limbs. The majority of the cankered limbs in the orchards of the state have this origin. The disease is found on the larger limbs more often than on the smaller, sometimes completely girdling them, thus causing the death of all parts beyond. The bark of the cankered spot becomes much roughened and the line between the dead and living tissue is often sharply marked, making the canker quite conspicuous. A fruiting stage similar to that on the apples is produced on the cankered limb. (See plate 15.)

Illinois Apple Tree Canker (*Nummularia discreta,* Tul.). This canker is often found on the large limbs and even on the trunks of trees. In fruiting the fungus produces conspicuous circular spots on the bark from an eighth to a

fourth of an inch in diameter. This canker is not so common nor so serious as the preceding one.

Leaf Spot (*Phyllosticta pirina* Sacc. & *P. Limitata* Pk.). This fungus produces brown, circular, sharply defined spots on the leaves. The disease has been a serious one in certain localities the past year. In some cases nearly all of the leaves had fallen by the middle of August, the tree being thus deprived of its carbon food supply during a large part of the summer. The disease has been worst in uncultivated orchards located on poorly drained soil. Spraying has had little or no effect upon the disease.

Baldwin Fruit Spot. This appears as small circular slightly sunken spots on the fruit, greatly injuring its appearance. It is especially common on Baldwins but also occurs on Porters and on other varieties. The cause of the disease is not known, but the fact that it is greatly reduced by spraying indicates that it is of fungous origin.

Fire-blight or Twig-blight (*Bacillus amylovorus* Burrill). This disease attacks the leaves and twigs of apple trees, causing the death of these parts. It has not been seen on apple trees the past year except when located near pear trees affected with the same disease.

Pear Diseases.

Pear Scab [*Fusicladium pirinum* (Lib.) Fckl.]. The scab on pears is very similar in appearance to that on apples. It has been common the past year only on the Flemish Beauty.

Fire-blight or Pear-blight (*Bacillus amylovorus* Burrill). This disease is of bacterial origin. The bacteria gain entrance to the twigs through wounds or through the flowers. The first evidence of the disease is the scorched and blackened appearance of the leaves. The shoots are also affected, the disease spreading rapidly backward through the branches, soon killing large limbs and sometimes the entire tree. Small drops of a mucilaginous fluid often ooze out of ruptures in the bark. In this fluid one finds myriads of bacteria. Insects feed upon this material and by their subsequent visits carry the disease to other plants.

Plum and Cherry Diseases.

Black Knot [*Plowrightia morbosa* (Schw.) Sacc.]. Black knot of the plum and cherry is one of the most conspicuous fungus diseases of New Hampshire. Early stages of this disease are found in the spring as irregular knotty swellings. At first these knots are yellowish brown in color and have a velvety surface. This appearance is due to the fact that the knots are at this time covered with a layer of spore-bearing stalks. The spores thus produced are capable of infecting other plants the same season. Later in the year the knots have become much enlarged and have turned from brown to a dead black. Upon close examination the surface of these knots is now found to have a rough uneven appearance, due to minute, closely crowded pimples or pustules. A miscroscopic study of these pustules shows them to contain club shaped cells or sacs filled with spores. These are the winter spores and serve to start the disease anew the next season. The enormous number of uncared for plum and cherry trees makes this an especially difficult disease to fight. Orchardists who have kept it out of their own orchards are compelled to be continually on guard to prevent its introduction from neglected plants. [See (a), plate 16.]

Brown Rot [*Sclerotinia fructigena* (Kze. & Schm.) Norton]. This is a very common disease of plums and may also attack cherries, peaches and apples. The fungus may be found on the leaves and the young shoots, but its characteristic results are found upon the fruit. Here it produces soft brown spots which rapidly enlarge, destroying the fruit. The fruit soon takes a powdery appearance due to the abundant production of the summer spores on its surface. The rotten plums often remain on the tree nearly all winter. The mycelium lives over winter in the mummified fruit, giving rise to spores the next season that serve to infect the new crop.

Grape Diseases.

Downy Mildew [*Plasmopora viticola* (B. & C.) Berl.]. So far as has been learned this disease appeared too late the past season to cause serious results. The fungus attacks all growing parts of the vine. On the leaves it produces pale green spots, which on the under surface are covered with a whitish, downy growth of spore bearing stalks. It attacks the fruit when only partly grown, producing a brown rot. Later the fruit is often covered with a downy coat of the fungus.

Bird's Eye Rot (*Sphaceloma ampelinum* De By.). This disease has been reported from several localities. It occurs on leaves, stems and fruit. On the latter it has a very characteristic appearance, forming circular, rotten spots with distinct, reddish brown margins.

Raspberry Diseases.

Anthracnose (*Gleosporium venetum* Speg.). This disease seriously affects raspberry canes and is sometimes found on the leaves. On the stems it produces purple spots which in the later stages of the disease have a whitish center. These spots often run together producing large patches of a grayish color. The parasite greatly reduces the vitality of the host plant and in some cases the disease has been so serious the past year as to prevent the maturing of any perfect fruit.

Crown Gall (*Dendrophagus globosus* (Toum.). The disease produces rough warty enlargements on the roots of the plants. It is supposed to be caused by one of the slime molds.

Potato Diseases.

Early Blight [*Alternaria solani* (Ell. et Mart.) Jones & Grout]. This disease appears early in the season but does not usually become very destructive until the plants have passed their stage of greatest vigor. It does not attack

the tubers. On the leaves it produces brown spots which often show faint concentric rings. Plants having this disease are often affected with the late blight also.

Late Blight (*Phytophthora infestans* De By.). The late blight has damaged the potato crop to a greater or less extent in every portion of the state from which information has been received. Even sprayed fields have not been entirely free from the disease. The early stages show black spots at the tips or edges of the leaves. On the under side of the leaf at the margins of these spots may be found a slight whitish growth. It is here that the spores of the fungus are produced. These spores spread the disease rapidly. The black spots enlarge, soon covering the entire leaf. The tubers from diseased plants often rot badly in storage, especially when stored in large piles. It is not certain to what extent this rotting is due to the above fungus. There is considerable evidence, however, that the fungus may pass the winter in the tubers.

Potato Scab (*Oospora Scabies* Thaxt.). This disease has been of common occurrence the past year, damaging many fields to the extent that few or no marketable tubers were obtained. Potatoes affected with the disease become peculiarly roughened and scabbed. At the time of digging the fungus sometimes shows as a slight whitish mold on the scabbed surface. The fungus can remain in the ground for several years and potatoes planted where the disease existed the year previous are almost certain to be infected.

Diseases of Cucumbers and Muskmelons.

Downy Mildew or Blight [*Plasmopora cubensis* (B. & C.) Humpf.]. The blight appears early in August as large, brown, angular spots on the leaves. These increase in number rapidly and the leaves soon die. The summer spores are produced on the under surface of the leaf on branching stalks. The winter stage of the fungus has never been found. The disease has been very common this year and

in many sections of the state the entire crop of cucumbers and muskmelons has been destroyed.

Leaf Mold (*Alternaria brassicae, var. nigrescens* Pegl.). This disease has also occurred on muskmelons. It can be distinguished from the blight by the lack of angularity in the spots produced.

Cabbage Diseases.

Club Root (*Plasmodiophora brassicae* Wor.). This disease has been found in several widely separated sections of the state. It produces gall-like swellings on the roots, due to the abnormal development of the host tissues. The plant is greatly weakened and heads poorly, if at all. The cause of the disease is one of the slime molds. These are peculiar organisms that in one stage of their life closely resemble the lower animal forms, but in other stages take a form and a manner of living that seem to make it necessary to call them plants. The parasite may live in the soil for several years and cabbage set where the disease existed the previous year are almost certain to be infected. See (b), plate 16.

Celery Diseases.

Leaf Blight (*Cercospora apii* Tres.). This is a very serious pest of gardeners. The fungus produces brown spots on the leaves, often causing them to turn yellow and take a sickly appearance.

Bean Diseases.

Anthracnose [*Colletotrichum lindemuthianum* (Sacc. et Magn.). Bri. et Cav.]. This fungus may attack the leaves of the host but is more common on the pods. Here it produces dark spots with a reddish border. The fungus spreads through the pods to the seeds, producing brown or yellowish discolorations on these. The disease has been so

common in some parts of the state the past year that it has been difficult to find beans in the markets that did not show its effects. The fungus can winter in the seeds and if diseased beans are planted it readily gets a start on the new crop.

BALDWIN FRUIT BUDS.

Aside from the work on plant diseases the department has started some experiments looking to the determination of the factors that control the formation of Baldwin fruit buds. The work has not yet been carried far enough to justify any definite conclusions, but the results thus far would indicate that trees that are accustomed to bear only on alternate years may be caused to produce their crop on the "off year".

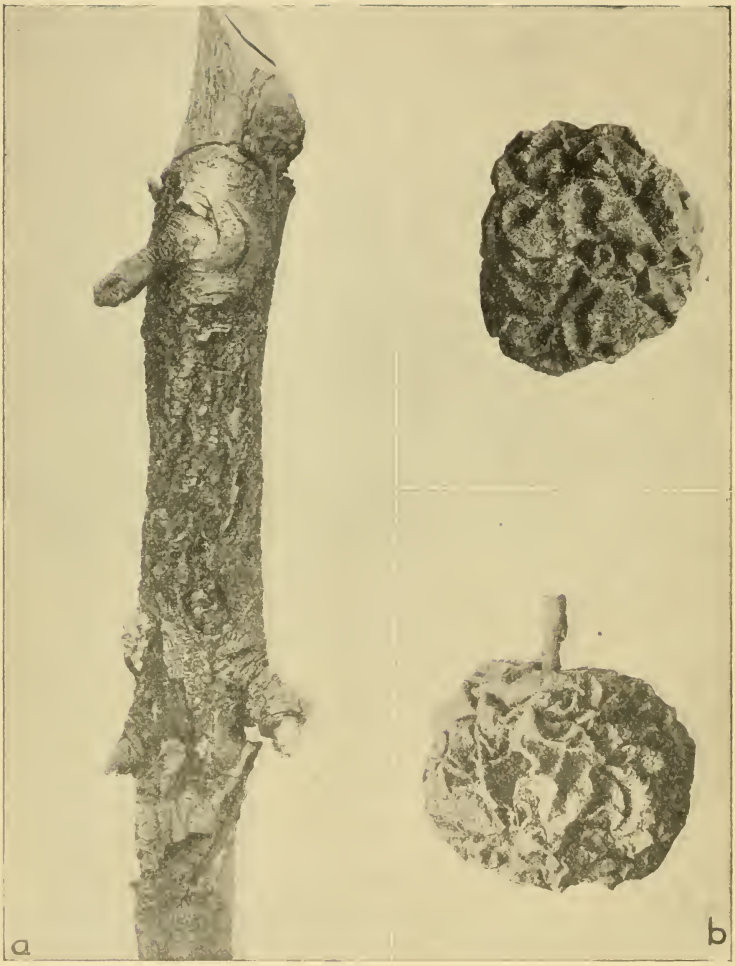

Plate 15. Black Rot fungus of apples. *a*, canker produced by black rot on apple branch, showing the minute pycnidia of the fungus; *b*, apples affected with the fungus, showing pycnidia on surface.

Plate 16. *a*. Cherry limb with early stage of Black Knot (photo by Lamson) ; *b*, cabbage affected with club root.